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Research Article

BIODIVERSITY OF BLUE GREEN ALGAE FROM SATARA DISTRICT (M.S.)

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ABSTRACT: Satara district is located in Western Ghats of Maharashtra. The district occupies 10,480 km^2area. The district includes 11 administrative tahasils viz., Satara, Karad, Patan, Jaoli, Wai, Mahabaleshwar, Phaltan, Maan, Khatav, Koregaon, Khandala. Entire district falls within Deccan trap area, however the common soil types are the black, loamy and clay. Some western part of district enjoys average annual rainfall exceeding 500 mm while eastern side has the rainfall less than 300 mm. These variations in environmental condition have helped this region to be rich in floral biodiversity. Present work was carried out to explore the diversity of blue green algae from Satara district. Variety of habitats from 82 localities were screened to explore blue green algae from the district. Between June 2010 to May 2013 in all 127 species from 36 genera belonging to 4 orders were recorded. Out of these 28 species were unicellular while 99 were filamentous. Filamentous forms were found to be dominant over unicellular forms.

Keywords: Biodiversity, Blue green algae, Satara district.

INTRODUCTION

Blue green algae or Cyanobacteria are phototrophic prokaryotic organisms. They inhabit almost all known photic habitats. They play important role in maintaining aquatic ecosystem and form base of food web (Thakur and Behere 2008). They show remarkable adaptations and surviving strategies because of which they survive under extreme environmental conditions. Therefore, they have become most successful organisms for survival even under stressed conditions. Factors controlling their distribution are pH, moisture, mineral nutrients, combined nitrogen etc. (Tiwari *et al*. 2005). Recently these organisms are known to generate pharmacologically active compounds (Singh *et al.* 2002). Now a days Blue green algae have been considered as a source of proteins (Subramanian 1996). During past few decades much work has been done on algal flora af rice fields throughout India (Devi et al 1999, Nayak et al 2001, Sinha *et al* 2003, Tiwary and Pandey 1976). Studies on blue green algae have been carried out from Western ghats of Maharashtra but most of the work was restricted to fresh water and paddy fields (Balkrishnan and Chougule 2002, Kolte and Goyal1985). Different regions of Maharashtra were explored to enumerate blue green algae (Ashtekar and Kamat 1980, Auti and Pingle 2006, Barhate and Tarar 1983a., Bhoge and Ragothman1986, Kamat 1962, 63, 64, 68, Mahajan and Mahajan1988b, 89, Nandan 2010, Sardeshpande and Goyal 1981). There are few reports on taxonomic work of blue green algae from Satara district but majority of the work was restricted to taxonomy of blue green algae from paddy fields (Karande 2009, Patil and Satav 1986); or particular taxonomic group (Ghadage and Karande 2008). Present investigation has been made to explore blue green algal diversity from Satara district of Maharashtra State of India.

MATERIALS AND METHODS

Study area

Satara district is located in Western part of Maharashtra in river basins of Bhima and Krishna. It is located between 17.5 to 18.11 N latitude and 73.33 to 74.33 to 74.54E. The climate ranges from rainiest region in Mahabaleshwar which has an average annual rainfall over 6000mm to driest region in Maan tahasil where average annual rainfall is about 300mm. Average maximum temperature recorded is 37.5^{0}C while 11.6^{0}C is the lowest average minimum temperature recorded. All these environmental conditions form a wide spectrum of microclimate for the growth and survival of diverse blue green algal forms and contribute to their diversity within the study area.

Algal samples from different localities of Satara district were collected during 2010-2013. All possible habitats like temporary and permanent water bodies, pools, puddles, tree barks, soil samples, were explored during different seasons.

Samples were preserved in 4% Formalin and deposited in laboratory of Y. C. Institute of Science, Satara while some promising forms were cultured and maintained in the laboratory.

Blue green algal forms were identified upto species level using standard literature. (Desikachary 1959 and Rippka1979, Anagnostidis and Komárek 1985) and microphotographs were taken with the help of webcam unit and *Olympus 20i* microscope.

Observations

Table 1: Locality wise distribution of blue green algal forms within the study area

Name of the organism	Locality	Habitat
Order: Chroococcales **Family: Chroococcaceae**		
Genus: *Aphanothece*		
Aphanothece microscopia Nag.	Yewteshwar Hill	Paddy field
A. naegeli Wartm	Yewteshwar Hill	Puddle
A. pallida(Kutz)Rabenh	Yewteshwar Hill, Pateghar, Morawle Ajinkyatara,	Paddy field Paddy field Wet soil
A. saxicola Nag.	Yewteshwar Hill	Paddy field
Genus: *Aphanocapsa*		
Aphanocapsa musicola Nag.	Karad(Malkapur)	Domestic sewage
A. roseana de Bary	Yewteshwar Hill, Nune, Medha	Temporary puddle
Genus: *Chroococcus*		
Chroococcus minutus(Kutz) Nag.	Yewteshwar Hill	Puddle, wall of water tank
C. pallidus Nag.	Yewteshwar Hill	Puddle
C. schizodermaticus West	Yewteshwar Hill	Moist rock
C. varius A. Br.	Yewteshwar Hill	Paddy field
Genus: *Gloeocapsa*		
Gloeocapsa atrata (Turp.)Kutz	Yewteshwar Hill, Kas, Kurneshwar, Ajinkyatara fort	Paddy field Paddy field wet soil
G. decorticans (A. Br.) Richter	Y.C. I. S. campus(Satara)	Wall of water tank
G.gelatinosa Kutz	Yewteshwar Hill	Puddle
G.polydermatica Kutz	Yewteshwar Hill, Ajinkyatara fort, Kas.	Paddy field, Puddle
G. luteofusca Martens	Yewteshwar Hill	Paddy field
G. aeruginosa Kutz	Karad (Canal area)	Puddle
G. livida (Carm) Kutz.	Karad (Canal area)	Puddle
Genus: *Gloeothece*		
Gloeothece palea (Kutz)Rabenh	Pateghar	Puddle
Genus: *Merismopedia*		
Merismopedia glauca(Ehrenb.)Nag.	Yewteshwar Hill, Yeralwadi (Waduj)	Ditch
M. punctata Nag.	Wai(Ghat)	Domestic sewage

Genus: *Microcystis*		
Microcystis aeruginosa Kutz.	Y.C. I. S. campus(Satara)	Moist walls
M. pulverea(Wood) Forti	Y.C. I. S. campus(Satara)	Ditch, Small puddle
M. elabens (Breb.)Kutz.	SGM College campus (Karad)	Moist soil
Genus: Microchaete		
Microchaete violacea Fremy	SGM College campus (Karad)	Moist soil
M. aequalis (Fremy) Comb.nov.	Yewteshwar Hill, Pateghar, Nune, Y.C. I. S. campus(Satara), Medha, Morawale	Puddle
M. tenera Thuret ex. Born Et. Flah.	Nune	Puddle
M. calothrichoides Hansgirg	Pateghar, Nune, Y.C. I. S. campus(Satara)	Puddle
Genus: *Fortea*		
Fortea bossei (Fremy) Comb.nov.	Yewteshwar Hill, Nune	Paddy field
Genus: *Synechococcus*		
Synechococcus aeruginosa Nag.	Yewteshwar Hill	Paddy field
S. pevalekii Mitra	Yewteshwar Hill	Paddy field
Family: Entophysalidaceae		
Genus: *Chlorogloea*		
Chlorogloea frischii Mitra	Umbraj	Decaying leaves at river margin
Order: Pleurocapsales **Family: Pleurocapsaceae**		
Genus: *Myxosarcina*		
Myxosarcina spectabilis Geitler	Y.C. I. S. campus(Satara)	Wall of building
Family: Hyellaceae		
Genus: *Hyella*		
Hyella caespitosa Born.et.Flah	Yewteshwar Hill	Rocky crevices
Order: Nostocales **Family: Oscillatoriaceae**		
Genus: *Arthrospira*		
Arthrospira tenius, Bruhl et Biswas	Ajinkyatara	Lake
A. platensis (Nordest.)Gomont	Kas	Puddle
Genus: *Spirulina*		
Spirulina subsalsa Oerst. ex. Gomont	Vasana river(Koregaon),Krishna river(Panchwad), Yeralwadi (Waduj)	Decaying leaves at the margins of river st
S. major Kutz. Ex Gomont	Vasava river(Koregaon), Tarali river(Umbraj), Krishna river(Mahuli), Kidgaon stream, Dhamner	In stream of river
Genus: *Oscillatoria*		
Oscillatoria anne Van Goor	Krishna river (Wai ghat), Yewteshwar Hill	Decaying leaves
O. sancta (Kutz.) Gomont	Daragah near Court Satara	Moist soil
O. ornata Kutz. ex Gomont	Naigaon(Shirwal)	Puddle

O. limosa Ag. ex Gomont	Krishna river (Wai ghat), Tarali river(Umbraj),	Puddle at the bank of river
O. obscura Bruhl et Biswas	Krishna river (Wai ghat), Y.C. campus(Satara), Pawarwadi	Wet soil (Mud)
O. subbrevis Schmidle	Krishna river (Wai ghat), Pateghar, Bombale, Kelghar ghat, Dhamner Kanher, Naigaon MIDC, Dabewadi, Kurneshwar, Shirsinge, Petri, Dewapur	Soil (Mud) Paddy field
O. curviceps Ag. ex Gomont	Pateghar, Yewteshar, Kas, Rethare khurd	Paddy field
O. princeps Vaucher ex Gomont	Pateghar, Varye, Krishna river (Wai ghat)	Moist soil
O. chalybea (Mertens) Gomont	Pogarwadi	Paddy field
O. proteus Skuja	Kanher, Kidgaon	Stream
O. jasorvensis Vouk.	Krishna river (Mahuli), Varye, Wai ghat	Moist soil at the bank of stream
O. mougeotii Kutz.	Kas plateau	Submerged on rocks
Oscillatoria nigra Vaucher	Parali	Biofilm on old temple
O. raoi De Toni, J.	Kas plateau, Dewapur	Puddle
O. vizagapatensis Rao, C.B	Tarali river(Umbraj), SGM campus Karad, Karad(Malkapur)	Submerged Rocks, Domestic sewage
O. fremyii De Toni, J.	Krishna river (Mahuli), Rahimatapur, Aundh	Stream Puddle
O. quadripunctata Bruhl et Biswa	Wengarutwadi (Pargaon khandala), Karad.	Soil, Domestic sewage
O. amoena (Kutz.)Gomont	Vasana river(Koregaon), Mardhe, Kurneshwar, Yewteshwar Hill, Dewapur	Moist soil
O. okeni Ag. ex Gomont	Pateghar, Dhamner, Pawarwadi	Moist soil
O. limnetica Lemm.	Vasana river(Koregaon), Salpe bandhara(Shirwal)	Stream
O. simlicissima Gomont	Dabewadi (Sajjangadh)	Puddle
O. prolifica (Grev.) Gomont	Kondawe	Roadside puddle
O. pseudogeminata G. Schmid	Veer dam, Kidgaon	Soil at margin of back flow of water stream
O. salina Biswas	Kidgaon	Moist soil
O. acuta Bruhl et Biswas	Yewteshwar	Along roadside
O. amphibian Gomont	S. G. M.college campus, Karad	Moist soil
O. chlorina Gomont	Karad(Saidapur)	Paddy field
Genus: *Phormidium*		
Phormidium stagnina Rao, C.B	Kas	Puddle
P. jadinianum Gomont	Janai Malai hill	Tree trunk
P. subincrustatum Fritsch et Rich	Yewteshwar	Moist soil

Genus: *Trichodesmium*		
Trichodesmium lacustre Klebahn	Kas, Sangwad (Patan)	Puddle, Domestic sewage
T. theibautii Gomont	Wai	Domestic sewage
Genus: *Lyngbya*		
Lyngbya polysiphoniae Fremy	Krishna river(Mahuli ghat)	Epiphytic on submerged plants
L. cryptovaginata Schkorbotow	Mahuli ghat, Kas, Daragah near Court satara, Pateshwar	Puddles
L. kuetzingiana Kirchner	Kas	Tree bark
L. perelegans Lemm.	Parali	Biofilm on wall and submerged plants
L. limnetica Lemm.	Vasana river(Koregaon)	Floating in water
L.chaetomorphae Iyengar et Desikachary	Kanher, Pateshwar	Floating in water
L. subtilis West, W.	Pateshwar	Tree bark
L. allorgei Fremy	Y. C. I. S. campus(Satara)	Moist soil
L. gracilis (Menegh.)Rabenh.	Paragon Khandala, Ganapati ghat (Dhom)	Puddle
L. spirulinoides Gomont	Malkapur (Karad)	Moist soil
L. stagnina Kutz.	Nandlapur(Karad)	Paddy field
L. magnifica Gardner	Wai(Ghat)	Domestic sewage
Genus: *Microcoleus*		
Microcoleus vaginatus (Vaucher) Gomont	Kas, Petri, Bamnoli, Talgaon	Paddy field
M. paludosus (Kutz) Gomont	Pateshwar, Mahabaleshwar, Karad	Biofilm on wall, moist soil, Domestic sewage
Family: Nostocaceae		
Genus: *Cylindrospermum*		
Cylindrospermum musicola Kutzing ex Born et. Flah	Pateghar	Moist soil near stream
C. indicum Rao, C.B. orth. Mut. De. Toni	Yewteshwar , Sangwad, Y. C. I. S.Campus(Satara)	Puddle, Domestic sewage
C. stagnale (Kutz.) Born et. Flah	Pateghar, Dabewadi	Paddy field soil
Genus: *Pseudoanabaena*		
Pseudoanabaena schmidlei Jaag. O	Y. C. I. S.Campus(Satara)	Puddle
Genus: *Anabaena*		
Anabaena spiroides Klebahn.	Saidapur, Kas, Yewteshwar	Puddle along roadside
A. oryzae Fritsch	Near Sajjangadh	Paddy field
A. khannae Skuja	Salpe bandhara(Shirwal), Yewteshwar, Mardhe, Karad(Oglewadi), Rethre	Moist soil, Paddy field, Sugar factory sewage
A. fertilissima Rao, C.B	Ajinkyatara, Kas, Falani	Pond and Moist soil
A. vaginicola Fritsch et Rich	Kas	Ditch near lake
A. doliolum Bhardwaja	Kondawe, Kas, Yewteshwar	Puddle
A. naviculoides Fritsch	Wengrutwadi	Moist soil near Bandhara
A. torulosa (Carm.)Legerh. ex. Born. et. Flah	Pratapgadh, Kas, Yewteshwar	Puddle
A. iyengarii Bhardwaja	Sajjangadh	Paddy field
A. laxa Rabehn.	Kas	Moist soil

Genus: *Nostoc*		
Nostoc muscorum Ag. ex Born et Flah	Vasana river(Koregaon)	Mud and rock at river bank
N. hatei Dixit	Thoseghar	on aquatic plants, In crevices of rocks of cave
N. commune Voucher ex Born et Flah	Kas, Yewteshwar, Mangalai temple area, Kelghar ghat	Moist soil, rocky substratum
N. microscopicum Carm. ex. Born. et. Flah	Mangalai temple area, Pratapgadh, Ajinkyatara, Pateghar	Moist rocky walls, tree trunk
N. punctiforme (Kutz.)	Pateghar	Paddy feild
N. calcicola Brebisson ex. Born. et. Flah	Kas	Moist rock
N. parmelioides Kutz. ex. Born. et. Flah	Kas	Paddy field
N. rivulare Kutz. ex. Born. et. Flah	Yewteshwar Hill	Moist rock
Genus:*Aulosira*		
Aulosira pseudoramosa Bhardwaja	Kas	Tree bark
Genus: *Richelia*		
Richelia intracellularis Johns. Schmidt.	Umbraj	Puddle
Family: Scytonemataceae		
Genus: *Plectonema*		
Plectonema gracillimum (Zof.)Hansgirg	Kas	Paddy field
Plectonema radiosum (Sciederm.) Gomont	Triputi	Biofilm on wall
Genus: *Scytonematopsis*		
Scytonematopsis woronichinii Kiss.	Kas	Paddy field
Genus: *Scytonema*		
Scytonema saleyeriense Weber van Bose	Sadar bazar	Wall, tree trunk
S. burmanicum Skuja	Parali. Triputi. Kas, Dewapur, Diwadi	Tree bark, biofilm Wet soil
S. julianum (Kutz.)Menegh.	Pateshwar	wall
S. cincinnatum Thuret ex. Born. et. Flah	Pateshwar	Submerged rock
S. amplum West et West	Kas, Thoseghar	Rocky substratum of waterfall
Genus: *Tolypothix*		
Tolypothix byssoidea (Berk.)Kirchner	Collector office,Satara	Tree bark
T. limbata Thuret	Thoseghar	On wall of cave in running water
T. rechingeri (Wille) Geitler	Pateghar	Tree bark
T. crassa West et. West	Yewteshwar	Tree bark
T. fragilis (Gardner)	Y. C. campus	Wall of building
T. arenophila West et. West	Mahabaleshwar	Tree bark
Family: Rivulariaceae		
Genus: *Rivularia*		
Rivularia aquatica De Wilde	Pateghar	Tree trunk
Genus: *Dichothrix*		
Dichothrix orsiniana (Kutz.) Born. et. Flah	Pateghar	Mud
Genus: *Calothrix*		
Calothrix marchia Lemm.	Pateghar	tree bark
C. fusca (Kutz.) Born. et. Flah	Kanher dam	Moist wall
C. bharadwajae De Toni, J.	Kas, Yewteshwar	Decaying leaves

Genus: *Gloeotrichia*		
Gloeotrichia indica Schmidle	Kanher dam	Moist wall
G. intermedia (Lemm.)Geilter	Pateghar	Tree bark
Order: Stigonematales **Family: Stigonemataceae**		
Genus: *Westiellopsis*		
Westiellopsis prolifica Janet	Ajinkyatara fort	Wet Soil
Genus: *Hapalosiphon*		
Hapalosiphon flagelliformis (Schmidle) Forti	Bhatmarali	Paddy field

Observation Table-2:

Chroococcales	26 Species	9 Genera	2 Families
Pleurocapsales	2 Species	2 Genera	2 Families
Stigonematales	2 Species	2 Genera	1 Family
Nostocales	97 Species	23 Genera	5 Families
Total number according to Orders: Thus, a total of 127 Species, 36Genera, 10Families and 4orders have been recorded			

RESULT AND DISCUSSION

Present investigation has shown richness of blue green algae in Satara district. The collections were made from 82 localities from different climatic zones of district. Of the 11 Tahasils Wai, Mahabaleshwar, Jaoli, Patan, Satara, Karad are located in the hilly parts while remaining tahasils Phaltan, Maan, Khatav, Koregaon, Khandala on the eastern parts are located in dry and drought prone areas. All probable habitats were screened for the occurrence of blue green algae (BGA). The observations showed occurrence of 127 species belonging to 36 genera from 10 families belonging to 4 orders of BGA (Desikachary 1959)

Order Pleurocapsales and Stigonematales were represented by minimum 2 species each. While Chroococcales was represented by 26 species. Order Nostocales showed presence of 97 species. The genus *Oscillatoria* was represented by maximum 27 species. Off the 127 species 49 species were heterocystous represent about 38.58 %. This clearly supports the fact that heterocystous nitrogen fixing form are well represented adding to the richness of fertility of soils.

CONCLUSION

All our observations support the fact that the most of the blue green algae were represented from western hilly areas while eastern dry part showed meager presence of blue green algal forms. Presence of some unique and promising form of blue green algae has encouraging which will certainly help further worker to carry out further studies on different lines such as biofertilizer, bioremediation etc.

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